Introduction to the Automated Geospatial Watershed Assessment Tool

Land Cover Variability and Hydrologic Response

Introduction: In this exercise you will investigate how the variability in land cover, soils, and topography affect the hydrology within the Las Vegas Valley. No repeat land cover classification yet exists for the valley, so we will substitute spatial for temporal variability in our assessment.

Goal: To continue to familiarize yourself with AGWA as a tool for investigating the connections between land cover and hydrology and the basin and watershed scale..

Assignment: Run the SWAT model several large watersheds in the Las Vegas Valley and the KINEROS model on several smaller subbasins using MRLC (NLCD) land cover from the early 1990's. Investigate the connection between urban growth and increased runoff and sediment yield.

Keywords: Watershed assessment, Hydrologic model, Rainfall interpolation, Continuous vs. event-based modeling

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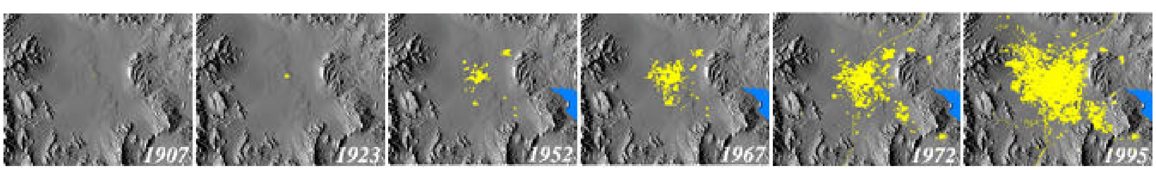
Some Background on the Las Vegas Valley

You may be familiar with the remarkable changes that have occurred in the Las Vegas Valley over the past 25 years, but here's a run-down on some significant figures (all data courtesy of the USGS, http://geochange.er.usgs.gov). In 1950 the population for Clark County was 48,289, and Las Vegas accounted for 24,624 of the total. In 1960, Clark County's population was 127,016; Las Vegas 64,405. Today, the Valley's population tops one million, but that doesn't include the tourist population which itself is estimated at 582,000. It is the fastest growing metropolitan area in the country. The figure below shows changes in the road and infrastructure within the Valley during this century:



As the population has grown, so has the associated paved area, and the changes on local and regional hydrology have been profound. Unfortunately, we do not have in our possession land cover data through time for the Valley, but we will substitute space for time and try to assess the impacts of urban growth on the hydrologic characteristics of the Basin.

Las Vegas GIS Data

Open the agwa project that you used in the previous exercises in the San Pedro River Basin. If the San Pedro view is still active, go ahead and close it. Open the Las Vegas view instead. If you loaded in the Las Vegas data at the start of yesterday's lab, it should already have the following data. If not, load these data into the view now:

Airport.shp - National Weather Service raingauge located at McCarron Airport
Vegas_soil.shp - STATSGO soils
Swat1.shp - outlet of a watershed to be modeled with SWAT

Swat2.shp - outlet of a watershed to be modeled with SWAT
Swat3.shp - outlet of a watershed to be modeled with SWAT
Kineros1.shp - outlet of a watershed be modeled with KINEROS
Kineros2.shp - outlet of a watershed to be modeled with KINEROS
Kineros2.shp - outlet of a watershed to be modeled with KINEROS
Vegas_accum - flow accumulation map (Grid)
Vegas_dir - flow direction map (Grid)
Vegas_dem - digital elevation model (Grid)
Vegas_mrlc - MRLC land cover classification (Grid)

You will also need the following database files loaded into the Tables:

Vegas49_87.dbf – Vegas rainfall data from 1949-1987 for the airport rain gauge
Precip.dbf – return period rainfall data for KINEROS
Soil_lut.dbf – master look-up table for soil parameters
Final_swat_soil_lut.dbf – SWAT look-up table
Final_kin_soil_lut.db – KINEROS look-up table

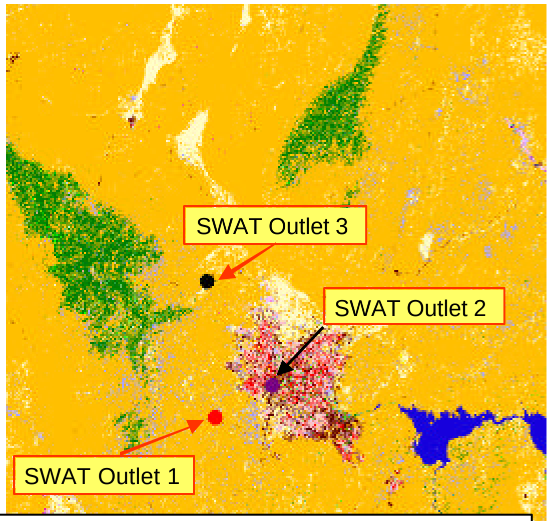
At this point we have all the data necessary to start modeling:
topography, soils, land cover, and rainfall.

Part I: Modeling Runoff Using SWAT

The general approach to today's exercise is to pick several watersheds that are varied in land cover characteristics and compare model results to try to pick out the various relationships among the GIS data layers and hydrology. Towards that end, we will model both KINEROS and SWAT on a couple of different basins.

Step 1. Delineate Watersheds for the SWAT Outlets

1. The outlets for the 3 subwatersheds to be modeled with SWAT are found at the following locations →



Go ahead and generate the watershed outlines for SWAT.

You will need to use these data in AGWA:
Vegas_DEM
Vegas_dir
Vegas_accum

Name the outlines as you wish, but keep the names such that you can remember which is which.

NOTE: ArcView seems to be fussy with some machines' memory. We have found it best to completely characterize each watershed for landcover, soils, and rainfall before moving on to the next watershed.

** If the time to complete the model runs for SWAT is overly long, do the runs for swat1 and swat2. **

Please use the following variables for modeling SWAT (so we can compare results to ensure that everything is going as planned:

Swat1: **CSA = 2500 acres**, name = lv_s1
Drainage area = 44873 acres (182 km^2)
Swat2: **CSA = 2500 acres**, name = lv_s2
Drainage area = 64735 acres (262 km^2)
Swat3: **CSA = 1500 acres**, name = lv_s3
Drainage area: 29926 acres (121 km^2)

Note that the watersheds contributing runoff the swat1 and swat2 share a watershed boundary but have quite different landscape characteristics.

Step 2. Intersect the Watersheds with Land Cover and Soil Data

1. For the Las Vegas Valley we have MRLC data (Vegas_MRLC) and STATSGO soils (Vegas_soil).

Step 3. Generate Rainfall Input

Once again we are going to use homogeneous rainfall data to separate the effects of land cover from the spatial variability in rainfall.

1. Use the **airport.shp** file and the **vegas49_87.dbf** rainfall data. Put the .pcp files into the "rainfall" directory as "vegas1.pcp", "vegas2.pcp", and "vegas3.pcp".
   - rain gauge point theme: airport.shp
   - rain gage ID filed is called "id".
   - unweighted precipitation file: vegas49_87.dbf

Step 4. Write Output and Run SWAT

2. For each of the watersheds, generate 15 years of runoff data.
   - Beginning data of simulation: January 1, 1949
   - use observed temperature data: **vegas49_87.tmp** in "agwa\datafiles".
   - Pick the weather generator file for Las Vegas
   - Results go in "simulations" as "vegas1", "vegas2", or "vegas3"

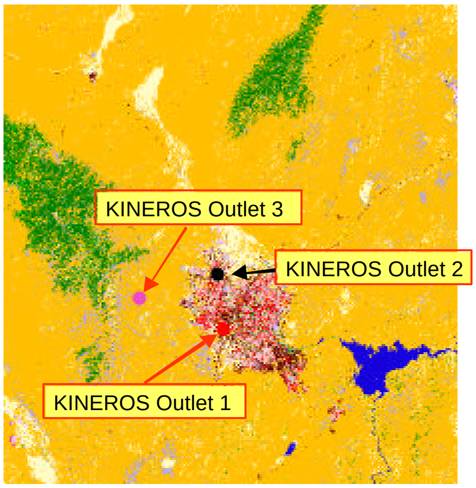
Step 5. View Results and Compare Variability Among Basins

1. Look at the results for each of the 3 basins, especially with regards to surface runoff and water yield. What patterns emerge when you look at the underlying land cover and topographic characteristics?

Part II: Modeling Runoff Using KINEROS

Step 1. Delineate Watersheds for the KINEROS Outlets

1. There are 3 outlets that may be used to generate watersheds for KINEROS: kineros1, kineros2, and kineros3. They are located as shown in the picture here.



You will need to use the same DEM, flow direction, and flow accumulation map you used in SWAT.

Again, run each of the watersheds in sequence through the generation of rainfall files. For some reason, this seems to be a more reliable way of getting through.

The watersheds sizes for the various watershed range from ~7 to over 89 km^2.

Please use the following settings & names so we can more easily compare results:

Kineros1: **CSA = 250 acres**, name = lv_kin1
Drainage area = 5876 acres (24 km^2)
Kineros2: **CSA = 300 acres**, name = lv_kin2
Drainage area: 1751 acres (7.1 km^2)
Kineros3: **CSA = 500 acres**, name = lv_kin3
Drainage area = 22784 acres (92 km^2)

Step 2. Intersect the Watersheds with Land Cover and Soil Data

1. For the Las Vegas Valley we have MRLC data (Vegas_MRLC) and STATSGO soils (Vegas_soil).

Step 3. Generate Rainfall Input

Once again we are going to use the ***10 year, 60-minute design storm***. This time, though, let's change the parameters a bit:

1. Watershed saturation index: ***0.5***
2. Output directory: "rainfall"
3. Rainfall names: k1_10yr60min.pre, k2_10yr60min.pre, k3_10yr60min.pre

Step 4. Write Output and Run KINEROS

1. Output directory: "simulations\kin_sims".
2. Parameter file names: kineros1.par, kineros2.par, kineros3.par

Step 5. View Results and Compare Variability Among Basins

1. As before, look at the results for each of the 3 basins, especially with regards to surface runoff and water yield. What patterns emerge when you look at the underlying land cover and topographic characteristics?